AN

INTRODUCTION

TO THE

USE OF THE GLOBES:

DIVIDED INTO

SHORT LESSONS;

WITH

QUESTIONS FOR EXAMINATION,

ANNEXED TO EACH LESSON.

F., M
K

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THE following Introduction to the uſe of the Globes *was drawn up, by the Author, in the form of* ſeparate leſſons, *for the uſe of ſome young pupils of his own; to whom they are intended to be delivered* ſingly—*a method which he has generally found to be attended with the happy effect of awakening curioſity, and exciting the conſtant pleaſing expectation of* ſomething new, *in the youthful mind. It is now printed in the ſame form, chiefly for the uſe of ſome of the Author's friends, who have been pleaſed to expreſs their approbation of this part of his plan. If any other perſons, into whoſe hands theſe leſſons may come, ſhould think that too much care will be required to preſerve ſo many detached papers from being torn or loſt; they may eaſily be ſewed or bound together at pleaſure.*

But the particular recommendation of the following Introduction to the uſe of the Globes, *it is preſumed, will be found to conſiſt in the* queſtions, *with which every leſſon is accompanied, the anſwers to which are not given, but left to be framed by the pupil himſelf, from a careful peruſal of the leſſon. To thoſe queſtions only, which are to be reſolved by the uſe of the Globes themſelves, the anſwers are added; without which they would have been of little uſe.*

W. F.

WARWICK, *May* 21, 1798.

LESSON I.

OF THE ARTIFICIAL GLOBE.

THE artificial Globe is a round, ſolid body; which repreſents the natural form and appearance of the Earth; and on which the different parts of it, as ſeas, continents, kingdoms, iſlands, are painted.

The Globe is made round, becauſe the Earth itſelf is known to be *ſpherical,* or of a round figure. For, ſeveral navigators, as Lord Anſon and Captain Cooke, by keeping the ſame courſe continually, from eaſt to weſt, have ſailed round the Earth: which they could not have done, if it had been of any other than a round figure. Beſides, the Earth's *ſhadow*, which falls upon the Moon, in the time of eclipſes, is always obſerved to be *circular;* which proves that the Earth itſelf muſt be round.

The artificial Globe is contrived to move round upon a ſpindle—which is called its axis—becauſe the Earth itſelf is known to have a ſimilar motion, once in twenty ſour hours, about its own axis —or that imaginary ſtraight line which paſſes directly through its centre. By means of this motion, the different parts of the Earth are preſented, each in its turn, to the Sun; and this is the cauſe of day and night. For, when any part of the Earth is turned *towards* the Sun, it is day in that part; and night when it is turned *from* it.

The Sun, the great ſource of light and heat, is an immenſely large body, fixed in the heavens, at the diſtance of about ninety five millions of miles from the Earth. Round this large body the Earth keeps continually moving; and it travels quite round it in about three hundred and ſixty ſive days, or once every year. The cauſe of the different ſeaſons, and the different lengths of the days and nights depend upon the Earth's annual revolution about the Sun: but this part of the ſubject belongs more properly to Aſtronomy.

QUESTIONS.

What is an artificial Globe? What do the differently-coloured parts of the Globe repreſent?—Why is the Globe made round? What is the firſt proof mentioned of the round figure of the Earth? What navigators have ſailed round the Earth? When is the Earth's ſhadow to be ſeen on the Moon? What is the figure of the Earth's ſhadow? What does the round figure of the Earth's ſhadow prove?—What motion has the artificial Globe? What is the axis of the Globe? Why is the Globe made to move round its axis? What is the axis of the Earth? How often does the Earth move round upon its axis? What is the cauſe of day and night? When is it day at any part of the Earth? When is it night at any part?—What is the Sun? What diſtance is the Sun from the Earth? What advantages are derived from the Sun? What other motion has the Earth beſides *that* round its own axis? What time is the Earth in going round the Sun? What great effects depend upon the Earth's annual revolution about the Sun?

LESSON II.

OF THE POINTS ON THE GLOBE.

The chief points on the Globe are the following:

1. The two poles of the Globe—Theſe are the two extreme points of the axis of the Globe: of which the one is called the *North*, and the other the *South* Pole.

2. The two equinoctial points—Theſe are the two points, where the equator and the ecliptic cut each other: the one is called *Aries*, or the ſpring equinox; the other *Libra*, or the autumnal equinox. They are called the *equinoctial* points becauſe, when the Sun appears in either of theſe points in the heavens, the days and nights are of *equal length* in all parts of the earth: which happens twice every year, in ſpring and autumn.

3. The two ſolſtitial Points—Theſe are the two points of the ecliptic, which are at the greateſt dif-

tance from the equator: the one is called *Cancer*, or the ſummer ſolſtice; the other, *Capricorn*, or the winter ſolſtice. They are called *ſolſtices* becauſe, when the Sun arrives at either of theſe points in the heavens, it ſeems to *ſtand ſtill* for ſeveral days, and then returns towards the other; which happens twice every year, in the ſummer and winter.

4. The two poles of the horizon—Theſe are the two points, one of which, directly over the head of the ſpectator, is called the *Zenith*; the other, which is directly under his feet, is called the *Nadir*.

5. The four cardinal points—Theſe are marked on the wooden horizon of the Globe, and are called North, South, Eaſt, Weſt. The great circle, called the meridian of any place, interſects the horizon in two oppoſite points; which are the *north* and *ſouth* points. And another great circle, croſſing that meridian at right angles, in zenith and nadir, will cut the horizon in two other points; which are the *eaſt* and *weſt* points.

QUESTIONS.

How many remarkable points are there on the Globe? What are the twelve points on the Globe? —What are the two poles of the Globe? What are the two poles of the Globe called?—What are the two equinoctial points? What are the two equinoctial points called? Why are they called equinoctial points? How often and at what times of the year are the days and nights equal, in all parts of the Earth?—What are the two ſolſtitial points? What are the two ſolſtitial points called? Why are they called ſolſtitial points? How often and at what times of the year does the Sun appear in the ſolſtices?—What are the two poles of the horizon? What are the two poles of the horizon called?—What are the four cardinal points called? Which are the north and ſouth points? Which are the eaſt and weſt points?

GEOGRAPHY.

How many remarkable points are there on the Globe? What are the twelve points on the Globe? — What are the two poles of the Globe? What are the two poles of the Globe called? — What are the two equinoctial points? What are the two equinoctial points called? Why are they called equinoctial points? How often and at what times of the year are the days and nights equal, in all parts of the Earth? — What are the two solstitial points? What are the two solstitial points called? Why are they called solstitial points? How often and at what times of the year does the sun appear in the solstices? — What are the two poles of the horizon? What are the two poles of the horizon called? — What are the four cardinal points called? Which are the north and south points? Which are the east and west points?

LESSON III.

OF THE CIRCLES ON THE GLOBE.

There are ten circles uſually drawn on the Globe; ſix great circles, and four leſs. The greater circles biſect each other; and they divide the Globe into two *equal* parts, called *hemiſpheres*. But the ſmaller circles do not cut each other; and they divide the Globe into two *unequal* parts.

The greater circles are—the Equator—the Ecliptic—the Horizon—the Meridian—the equinoctial Colure—the ſolſtitial Colure.

The ſmaller circles are—the two Tropics—the two Polar Circles.

Beſides theſe, there are a number of circles drawn upon the Globe, parallel with the equator. Theſe are called *parellels of latitude*.

There are alſo a number of other circles *ſuppoſed* to be drawn round the Globe, all meeting in the zenith and nadir of any place, and cutting the horizon at right angles. Theſe are called *azimuth* or *vertical circles.*

Every circle, great or ſmall, is ſuppoſed to be divided into three hundred and ſixty equal parts, which are called *degrees* (marked °); and each of theſe degrees is again ſuppoſe to be divided into ſixty equal parts, which are called *minutes* (marked). So that every circle contains 360°.—the half of a circle, or ſemicircle 180°.—and the quarter of a circle or quadrant 90°.

A degree is equal to ſixty nine Engliſh miles and a half.

QUESTIONS.

How many circles are there upon the Globe? How are the ten circles divided? What is obſerved of the great circles? What is obſerved of the ſmaller circles?—What are the ſix great circles called? What are the four ſmaller circles called? What other circles are uſually drawn upon the Globe? What are theſe circles called? What other circles are *ſuppoſed* to be drawn on the Globe? What are theſe circles called?—How is every circle on the Globe divided? What are theſe equal parts called? What is the mark for degrees? How is every degree divided? What are the ſixty equal parts of a degree called? What is the mark for minutes? How many degrees are there in a circle? How many degrees are there in a ſemicircle? How many degrees are there in a quadrant? How much is a degree in Engliſh miles?

LESSON IV.

OF THE EQUATOR, OF THE ECLIPTIC.

1. The Equator, called alſo the Equinoctial Line, and ſometimes the Line, is that great circle, which encompaſſes the middle of the Globe; and which is, in every part, at equal diſtance from its two poles.

This circle divides the Globe into two equal parts, called the northern and ſouthern *hemiſpheres;* and hence it takes its name of the *equator* or *equaller*. It is alſo called the *equinoctial*, becauſe, when the Sun appears on this line, the days and nights are of equal length all over the world.

The equator is divided into 360 degrees, reckoned eaſtward from Aries, one of the points in which the ecliptic interſects the equator. It is alſo generally numbered, on Engliſh Globes, both eaſtward and weſtward to 180 degrees, from that great ſemicircle which paſſes through London, called its meridian, to the oppoſite ſemicircle—where eaſt and weſt with reſpect to London unite.

2. The ecliptic is that great circle, which croſſes the equator, in the two oppoſite points of Aries and Libra; and which touches the two tropics, in the two oppoſite points of Cancer and Capricorn.

This circle ſhews the path in the heavens, in which the Sun appears to travel every year, in moving from the ſummer to the winter ſolſtice; and again from the winter to the ſummer ſolſtice. In this circle, the Sun appears to advance nearly 1°. every 24 hours; and 30°. every month; till it has paſſed through the whole 360°. which anſwer nearly to the number of days in a year (365 days, 6 hours, 56 minutes).

The ecliptic paſſes through the middle of a broad circle, called the *Zodiac;* of which an account will be hereafter given.

QUESTIONS.

What is the equator? Why is this circle called the equator? Why is this circle called the equinoctial? How are the degrees on the equator numbered? In what other way are the degrees of the equator numbered, on Engliſh Globes?—What is the ecliptic? What great circle in the heavens does the ecliptic repreſent? What are the two points, between which the ſun appears to travel every year? How far does the Sun appear to move in the ecliptic every 24 hours, and how far every month? How nearly do the degrees of the ecliptic anſwer to the number of days in a year?—What is the broad circle called, through which the ecliptic paſſes?

LESSON V.

OF THE SIGNS OF THE ZODIAC.

The Zodiac is that broad circle in the heavens, which extends about 8°. on each ſide of the ecliptic, being in its whole breadth 16°. Within this circle are the fixed ſtars over which the Sun paſſes, in his apparent annual courſe; and which are divided into twelve ſigns or conſtellations—called the *twelve ſigns of the zodiac*—each diſtinguiſhed by a particular name and character.

The twelve ſigns, being marked upon the ecliptic, divide it into twelve equal parts, which correſpond to the twelve months in the Year. Each of theſe parts is again divided into 30°. which correſpond nearly to the days of the months. The Sun, in its apparent annual courſe, advances through one of theſe ſigns every month; and, in each month, appears in its correſponding ſign of the zodiac.

The following are the names and characters of the twelve ſigns, placed oppoſite to the correſponding months of the year.

1. Aries, the Ram	March
2. Taurus, the Bull	April
3. Gemini, the Twins	May
4. Cancer, the Crab	June
5. Leo, the Lion	July
6. Virgo, the Virgin	Auguſt
7. Libra, the Balance	September
8. Scorpio, the Scorpion	October
9. Sagittarius, the Archer	November
10. Capricornus, the Goat	December
11. Aquarius, the Waterman	January
12. Piſces, the Fiſh	February

Of theſe twelve ſigns the firſt ſix are called, in our northern hemiſphere, the *ſummer ſigns*, and are ſituated on the north ſide of the equator: the other ſix are called the *winter ſigns*, and are ſituated on the ſouthern ſide of the equator.

QUESTIONS.

What is the Zodiac? What ſtars are within this broad circle, and how are theſe ſtars diſtinguiſhed? What are the twelve ſigns called?—How is the ecliptic divided? What do the twelve ſigns of the ecliptic correſpond to? How are the twelve ſigns of the ecliptic divided? What do the thirty degrees of each ſign correſpond to? How far does the Sun appear to advance in the ecliptic every month? In what ſign does the Sun appear in each month?—What are the names of the twelve ſigns? What month of the year do Capricornus—Leo—Libra—Taurus—Piſces—Gemini—Sagittarius—Virgo—Scorpio—Aries—Aquarius—Cancer—correſpond to?——What are the ſigns which correſpond to April—October—July—January—May—March February—November—June—September—Auguſt—December?——Which are our ſix ſummer ſigns? Which are our ſix winter ſigns?

LESSON 4.

What is the Zodiac? What ſtars lie within this broad circle, and how are theſe ſtars diſtinguiſhed? What are the twelve ſigns called?—Into what is the ecliptic divided? What do the [illegible] apparent di[illegible] ecliptic correſpond to? How are the twelve ſigns of the ecliptic divided? What do the thirty [illegible] of each ſign correſpond to? How far does the Sun appear to advance in the ecliptic every day? In what ſign does the Sun appear each month? What are the names of the twelve ſigns? What month of the year do Capricorn — Piſces — Taurus — Leo — Gemini — Sagittarius — Virgo — Scorpio — Aries — Aquarius — Cancer — correſpond to? — What are the ſigns which correſpond to [illegible] — October — July — January — April — March [illegible] November — June — September — Auguſt [illegible] appear in? — Which are called ſummer ſigns? Which are the winter ſigns? [illegible] correſponding [illegible] ſigns?

LESSON VI.

OF THE HORIZON.

3. The Horizon is diſtinguiſhed into the *viſible* and the *rational.*

The viſible horizon, is that circle you ſee around you, in a clear day, where the ſky and earth, or water, ſeem to meet—and parallel to this, at the middle part of the Globe, is the rational horizon.

Though there is in reality a vaſt difference between the viſible and the rational horizon, yet, at the immenſe diſtance of the heavenly bodies, this difference would appear as nothing. And as the horizon is chiefly conſidered in relation to the heavenly bodies; therefore the viſible and the rational horizon may, without any ſenſible error, be reckoned one and the ſame.

It is only the rational horizon which is repreſented on the Globe—by that broad wooden circle, which encompaſſes the whole. This circle ſhews the riſing and the ſetting of the Sun, Moon, and Stars; which are ſaid *to riſe* when they come above it, and *to ſet* when they go below it.

Every place upon the earth has its own horizon: and whenever we change our ſituation upon the earth, we change likewiſe our horizon. By moving the Globe, till any given place be in the zenith—the wooden horizon is made to repreſent truly the rational horizon of that place.

On the wooden horizon four circles are uſually drawn. In the outermoſt circle are the 12 months divided into days. In the next circle are the ſigns of the zodiac, with their names and characters, divided into degrees; each degree being placed oppoſite to the day of the month to which it correſponds. The third circle is marked with the points of the mariner's compaſs; it is divided, by the four cardinal points, into four quarters; and each quarter is again divided into eight points; in all 32 points. The remaining circle is divided into 4 quadrants.

All the other points of the compaſs are diſtinguiſhed by particular names—compounded of *thoſe* of the four cardinals. Thus from North towards Eaſt—the firſt point is called *North by Eaſt*—the ſecond, *North North Eaſt*—the third, *North Eaſt by North*—and the middle point, *North Eaſt.*—From Eaſt towards North the firſt point is called *Eaſt by North*—the ſecond, *Eaſt North Eaſt*—the third *North Eaſt by Eaſt*—and the middle point as before *North Eaſt*—. The other points of the compaſs are diſtinguiſhed by names ſimilarly compounded. *See the Globe.*

QUESTIONS.

What is the third great circle on the Globe? How is the horizon diſtinguiſhed? What is the viſible horizon? What is the rational horizon? What is the real difference between the viſible and the rational horizon? and what the apparent difference, viewed from any of the heavenly bodies? In what relation are the viſible and the rational horizon conſidered as the ſame?—Which horizon is repreſented by the wooden horizon? What is the riſing and ſetting of the heavenly bodies?—Why is the horizon ſometimes called a *changeable* circle? How is the horizon of any given place repreſented by the Globe?—How many circles are uſually drawn on the wooden horizon?—What is the firſt of theſe circles?—What is the ſecond? How are the degrees of the twelve ſigns placed, with reſpect to the days of the month?—What is the third circle? How many points of the compaſs are there in all? How are the 32 points divided?—What is the fourth circle?—How are the 32 points of the compaſs diſtinguiſhed? What is the 2d. point from N. towards E.? What is the middle point? What is the 1ſt point? What is the 3d point? What is the 1ſt point from E. towards N.? What is the 3d point? What is the 2d point?—What is the middle point between N. and W.? What is the 2d point from N. towards W.? What is the 2d point from W. towards N.?—What is the 3d point from S. towards E.? What is the 1ſt point from E. towards S.?—What is the middle point between S. and W.? What is the 2d point from S. towards W.? &c.—

⁂ *For the anſwer to the ſeven laſt queſtions, ſee the horizon of the Globe.*

LESSON VII.

OF THE MERIDIANS. OF THE COLURES.

4. Semicircles, reaching from pole to pole, and cutting the equator at right angles, are called *Meridians*, from *meridies*, i. e. mid-day; becauſe, whenever the Sun, is directly over the meridian of any place, it is *noon* at that place.

Every place upon the earth has its own meridian. Meridians, therefore, may be conceived to paſs through *every point* of the Globe's ſurface; though only a certain number of them are actually drawn upon it.

All places, which lie under the ſame ſemicircle, are ſaid to be in the *ſame meridian;* as, for inſtance, Cork, Vigo, Oporto, &c. and all places, which lye under the ſemicircle oppoſite to that, are ſaid to be in *oppoſite meridians;* as ſome parts of New Zealand, &c. All the former places have their noon at the *ſame* hour; and the latter, at *oppoſite* hours: ſo that, when it is 12 at *noon* at the former, it is 12 at *night* at the latter places.

The brazen meridian, fixed to the Globe, repreſents the meridian, and the oppoſite meridian, of *any* place that is brought directly under it. It divides the Globe into the *eaſtern* and *weſtern* hemiſpheres.

Any meridian may be aſſumed, at pleaſure, for the *firſt meridian.* By Engliſh Geographers, the Royal Obſervatory at *Greenwich,* near London, is generally accounted the place of the firſt meridian.

Meridians, drawn upon the Globe, at the diſtance of 15°. from each other, are called *Hour Circles;* of which there are 24, correſponding to the hours of the day and night. They are ſo called becauſe, by the Earth's diurnal rotation, the Sun appears to move from one meridian to another in the ſpace of an hour, and thro' all of them in 24 hours. Thoſe places, therefore, that lie under any one of theſe meridians, have their time of noon, and every other hour of the natural day, one hour *earlier,* than thoſe places under the next meridian *weſtward:* and one hour *later* than thoſe under the next meridian *eaſtward.* Thus it is noon at London, one hour later than at Frankfort-upon-Oder; and one hour earlier, than at the places a little eaſtward of Cape Verd.

5. 6. The Equinoctial and Solſtitial Colures—are two great Circles, drawn only on the celeſtial Globe; the one through the Solſtitial, and the other through the Equinoctial points: and both of them, at right angles with the equator.

QUESTIONS.

What are the meridians? Why are they called meridians? What number of meridians are *conceived* to be drawn upon the Globe?—What places are ſaid to be in the ſame meridian? What places are ſaid to be in the oppoſite meridian? What is remarked of the time of noon, at places in the ſame, and in oppoſite meridians? When it is 12 at noon at any meridian, what hour is it at the oppoſite meridian?—What is the uſe of the braſs meridian? How does the braſs meridian divide the Globe?—What is the firſt meridian? What is the firſt meridian on Engliſh Globes?—What are the hour circles, and how many are there? Why are they called hour circles? What is the difference in the time of noon and of every hour of the natural day at any three adjacent meridians? What is the difference in the time of noon at London, Frankfort and the places near Cape Verd?——What are the two Colures?

LESSON VIII.

OF THE SMALLER CIRCLES. OF THE HORARY CIRCLE, AND THE QUADRANT OF ALTITUDE.

1. 2. The two Tropics—are two ſmaller circles, parallel to the equator, at the diſtance of 23°. ½ from it—one on the northern ſide, called the *tropic of Cancer*—the other on the ſouthern ſide, called the *tropic of Capricorn.*

They are called *tropics* from a Greek word which ſignifies "to turn," becauſe, when the Sun arrives at either of them, he ſeems to *return* again towards the equator.

When the Sun is in the tropic of Cancer, it is the *longeſt* day in the *northern*, and the *ſhorteſt* day in the *ſouthern* hemiſphere. On the contrary, when the Sun is in the tropic of Capricorn, it is the *longeſt* day in the *ſouthern*, and the *ſhorteſt* day in the *northern* hemiſpheres.

3. 4. The two Polar circles—are two ſmall circles, parallel to the equator, at the diſtance of 66°. ½

from it—one on the northern ſide, called the *Arctic Circle* (from Arctos, a bear, the name of a conſtellation near it)—the other on the ſouthern ſide, called the *Antarctic Circle.*

THE HORARY CIRCLE.

The ſmall braſs circle, with the index, fixed at the north pole of the Globe, is called the *Horary Circle.* It is divided into twice 12 hours, anſwering to the time in which the Earth performs its diurnal revolution. The upper 12 denotes noon; the lower, night.

THE QUADRANT OF ALTITUDE.

The thin flexible ſlip of braſs, with one of its edges graduated into 90°. is called the *Quadrant of Altitude;* from its uſe in meaſuring the altitude, or heighth, of the Sun or Stars, above the horizon. It is alſo of uſe to ſhew the *bearings of places*, or the point of the compaſs, which one place bears on with reſpect to another.

QUESTIONS.

What are the two tropics? What is the northern tropic called? What is the ſouthern tropic called? Why are they called tropics? What is the length of the days, in the different hemiſpheres, when the Sun is in the tropics?—What are the two Polar Circles? What is the northern polar circle called? What is the ſouthern polar circle called? ——What is the horary circle? How is it divided?———What is the Quadrant of Altitude? Whence does it take its name? What is the bearing of places?

QUESTIONS.

What are the two tropics? What is the northern tropic called? What is the southern tropic called? Why are they called tropics? What is the length of the days in the different seasons, when the sun is in the tropics?——What are the two Polar Circles? What is the northern polar circle called? What is the southern polar circle called? ——What is the horary circle? How is it divided?——What is the Quadrant of Altitude? Whence does it take its name? What is the bearing of places?

LESSON IX.

OF LATITUDE AND LONGITUDE.

The LATITUDE of any place is its diſtance from the equator: it is ſaid to have north latitude, if in the northern hemiſphere; and ſouth latitude, if in the ſouthern hemiſphere.

The latitude is found by bringing the given place to the graduated edge of the braſs meridian; which is numbered, for that purpoſe, from the equator both ways to the poles. The degree, directly over the given place, ſhews the latitude.

The latitude of any place is always equal to *the elevation of the pole*, in the ſame place, above the horizon, i. e. the pole is always as many degrees, above the horizon of any place, as that place is diſtant from the equator. For this reaſon, the latitude is ſometimes expreſſed by the "pole's height" or "elevation of the pole."

Thoſe places which lie under the equator have no latitude, it being there that latitude begins: and no place can have more than 90° of lat. which is the diſtance of the poles—where latitude ends.

All places, at the ſame diſtance from the equator, on the ſame ſide of it, are ſaid to be in the ſame *parallel of latitude*.

Degrees of latitude are all equal to 60 geographical or 69½ Engliſh miles.

THE LONGITUDE of any place is its diſtance from the firſt meridian: it is ſaid to have eaſt longitude, if on the eaſtern ſide; and weſt longitude, if on the weſtern ſide of it.

The degrees of longitude are marked on the equator. To find the longitude—let the given place be brought to the braſs meridian: then, that degree of the equator, over which the meridian paſſes, ſhews the longitude.

Thoſe places which lie under the firſt meridian have no longitude, it being there that longitude begins: and no place can have more than 180° of longitude, eaſt or weſt, which is the diſtance from the firſt meridian, to its oppoſite meridian—where longitude ends. But longitude is ſometimes reckoned eaſtward, quite round the equator, in which caſe the greateſt longitude will be 360°.

Degrees of longitude are not every where *equal*, like thoſe of latitude. For, as the meridians continually approach towards one another, from the equator to the poles, where they all meet in a point; in the ſame proportion, the degrees of the longitude muſt continually grow leſs. Thus the diſtance between any two meridians meaſured in Lat. 60° is only half the diſtance between the ſame meridians meaſured on the equator: conſequently in Lat. 60° a degree of longitude is but half the quantity of a degree on the equator—The number of miles equal to a degree of longitude, in ſeveral different latitudes, are as follows;

At the equator—a degree of long. is equal to—60 miles

In latitude	15 - - - - - - - - - - - - -	58 ——
————	26 - - - - - - - - - - - - -	54 ——
————	40 - - - - - - - - - - - - -	46 ——
————	47 - - - - - - - - - - - - -	41 ——
————	60 - - - - - - - - - - - - -	30 ——
————	70 - - - - - - - - - - - - -	20½--nearly
————	80 - - - - - - - - - - - - -	10½— ——
————	90 - - - - - - - - - - - - -	0 —

QUESTIONS.

What is latitude? On what circles are the degrees of latitude marked? How is latitude found? Why is latitude ſometimes expreſſed by "the pole's height"? What places have no latitude? What is the greateſt latitude? How much is a degree of latitude in miles?——What is longitude? On what circle are the degrees of longitude marked? How is longitude found? What places have no longitude? What is the greateſt longitude? If longitude be reckoned only eaſtward, what is the greateſt longitude?—What is the difference between degrees of latitude and longitude, in different places? What is the reaſon that degrees of longitude grow leſs, at greater diſtances from the equator? What is the difference in the diſtance of any two meridians from each other, meaſured on the equator, and in lat. 60°? What is the difference in a degree of longitude at the equator and in lat. 60°?—How many miles is a degree of longitude—at the equator—in lat. 70°—in lat. 47°—in lat. 26°—in lat. 80°—in lat, 15°—in lat. 40°—in lat. 90°—in lat. 60°?

LESSON X.

OF THE CLIMATES.

It being obſerved that the day is always 12 hours long at the equator, and that the length of the longeſt day increaſes in proportion to the diſtances from it—ancient Geographers divided the whole earth into certain diſtricts, which they called *Climates;* and inſtead of deſcribing the ſituation of places by the latitude and longitude, they uſed to mention the climates in which they were ſituated.

This method of dividing the earth into climates, though now very much diſuſed, has been adopted by ſeveral modern Geographers. From the equator to the poles, they reckon 30 climates each way. Of theſe, the firſt 24 fall between the equator and the polar circles; and in all theſe climates, the length of the longeſt day increaſes by *half hours.* The remaining 6 climates lie between the polar circles and the poles; and in them, the length of the longeſt days increaſes by *months.* The former are called hour-climates; the latter month-climates.

TABLE OF THE CLIMATES.

24 Climates from the Equator to the Polar Circles

Climates.	Ends in latitude of		Where the longeſt day is		Climates.	Ends in latitude of		Where the longeſt day is	
	Deg	Min	H	Min		Deg	Min	H	Min
1	8	25	12	30	13	59	58	18	30
2	16	25	13		14	61	18	19	
3	23	50	13	30	15	62	25	19	30
4	30	25	14		16	63	22	20	
5	36	28	14	30	17	64	6	20	30
6	41	22	15		18	64	49	21	
7	45	29	15	30	19	65	21	21	30
8	49	1	16		20	65	45	22	
9	52	0	16	30	21	66	6	22	30
10	54	27	17		22	66	20	23	
11	56	37	17	30	23	66	28	23	30
12	58	29	18		24	66	31	24	

6 Climates from the Polar Circles to the Poles

Climates.	Ends in latitude of		Where the longeſt day is	Climates.	Ends in latitude of		Where the longeſt day is
	Deg	Min	Months		Deg	Min	Months
1	67	21	1	4	78	30	4
2	69	48	2	5	84	5	5
3	73	37	3	6	90		6

QUESTIONS.

What was the obſervation, with reſpect to the length of the longeſt days, which led to the ancient diviſion of the earth into climates? What was the *ancient*, and what is the *modern* method of deſcribing the ſituation of places?—How many climates are there, according to modern Geographers? What is the ſituation of the firſt 24 climates? What is the difference in the lengths of the longeſt days in in theſe climates? What is the ſituation of the 6 remaining climates? What is the difference in the lengths of the longeſt days in theſe climates? By what names are the climates diſtinguiſhed?—How far do the firſt ſix climates extend from the equator, and what is the length of the longeſt day in theſe climates? How far do the ſecond 6 climates extend, and what is the length of the longeſt day in them? How far do the third 6 climates extend, and what is the length of the longeſt day in them? How far do the fourth 6 climates extend, and what is the length of the longeſt day in them? How far do the 6 remaining climates extend, and what is the length of the longeſt day in them?

LESSON XI.

NAMES OF COUNTRIES AND REMARKABLE PLACES, SITUATED IN EVERY CLIMATE NORTH OF THE EQUATOR.

1. Climate. Longeſt Day. 12½ hours. Malacca. Surinam. Cayenne.

2. C. L. D. 13 hours. Abyſſinia. Madraſs. Pondicherry. Tobago. Barbadoes.

3. C. L. D. 13½ hours. Mecca. Bombay. Part of Bengal. Canton. Jamaica. Hiſpaniola.

4. C. L. D. 14 hours. Egypt. Canary Iſles. Delhi. Eaſt Florida. Havanna.

5. C. L. D. 14½ hours. Gibralter. Jeruſalem. Nankin. Weſt Florida. Georgia. The Carolinas.

6. C. L. D. 15 hours. Liſbon. Madrid. Minorca. Part of Greece. Aſia Minor. Samarcand. Pekin. Japan. Corea. Williamſburgh. Maryland. Philadelphia.

7. C. L. D. 15½ hours. North part of Spain. South part of France. Turin. Genoa. Rome. Conſtantinople. New York. Boſton in New England.

8. C. L. D. 16 hours. Paris. Vienna. Canada.

9. C. L. D. 16½ hours. London. Prague. Dreſden. Flanders. Cracow. South part of Ruſſia.

10. C. L. D. 17 hours. Dublin. York. Holland. Hanover. Warſaw. Labrador.

11. C. L. D. 17½ hours. Edinburgh. Copenhagen. Moſcow.

12. C. L. D. 18 hours. South part of Sweden. Tobolſki.

13. C. L. D. 18½ hours. Orkney Iſles. Stockholm.

14. C. L. D. 19 hours. Bergen. Peterſburgh.

15. C. L. D. 19½ hours. Hudſon's Streights.

16. C. L. D. 20 hours. Siberia. South part of Weſt Greenland.

17. C. L. D. 20½ hours. Drotheim in Norway.

18. C. L. D. 21 hours. Part of Finland.

19. C. L. D. 21½ hours. Archangel on the White Sea.

20. C. L. D. 22 hours. Hecla in Iceland.

21. C. L. D. 22½ hours. Northern parts of Ruſſia. and Siberia.

22. C. L. D. 23 hours. New North Wales in America.

23. C. L. D. 23½ hours. Davis' Streights.

24. C. L. D. 24 hours. Samoieda.

25. C. L. D. 1 month. South part of Lapland.

26. C. L. D. 2 months. North part of Weſt Greenland.

27. C. L. D. 3 months. Zembla Auſtralis.

28. C. L. D. 4 months. Zembla Borealis.

29. C. L. D. 5 months. Spitſbergen.

30. C. L. D. 6 months. Unknown.

QUESTIONS.

What is the length of the longeſt days in—Egypt—Canada—Bergen—New York—Orkney Iſles—Nankin—Vienna—Tobago—Delhi—Rome—Cracow—Labrador—Spitſbergen—Liſbon—London—Gibralter—Eaſt Florida—Conſtantinople—Boſton—Edinburgh—Havanna—Prague—Drontheim—Aſia Minor—Pekin—Abiſſinia—Madrid—Hecla—Mecca—Tobolſki—Turin—Canary Iſles—York—Williamſburgh—The Carolinas—Warſaw—Japan—Pondicherry—Paris—Dublin—Davis' Streights—Dreſden—Philadelphia—Canton—Cayenne—Samoieda—Flanders—Bombay—Weſt Florida—Samarcand—Barbadoes—Corea—Holland—South Part of Sweden—Jeruſalem—Georgia—Northern Parts of Spain—South Part of Ruſſia—Minorca—Hanover—Madraſs—Moſcow—Siberia—Zembla Borealis—Maryland—Jamaica—Part of Finland—Malacca—South Part of Lapland—Stockholm—Part of Greece—Archangel—South Part of Weſt Greenland—Peterſburgh—Zembla Auſtralis—Part of Bengal—Hudſon's Streights—Copenhagen—New North Wales—Surinam—Genoa—The North Pole—South Part of France—North Parts of Ruſſia and Siberia—Hiſpaniola—North Part of Weſt Greenland?

LESSON XII.

OF THE FIVE ZONES. OF THE SPHERES, &c.

Beſides the diviſion into climates—the whole globe was alſo divided, by the ancients, into five large portions, called *zones*, from a Greek word which ſignifies a girdle, being broad ſpaces, like ſwathes, girding the earth about.

1. The Torrid Zone—lies between the two tropics; and is called *torrid*, becauſe it was ſuppoſed to be ſo hot that people could not live there. But this notion has long ſince been found to be a miſtake.

2. 3. The two Temperate Zones—are compriſed between the tropics and the polar circles; and are called *temperate*, becauſe a moderate degree of the ſun's heat is here enjoyed.

4. 5. The two Frigid Zones—lie between the polar circles and the poles; and are ſo called, becauſe moſt parts of the year it is there extremely cold; yet not ſo much ſo but that people contrive to live there, and perhaps not very uncomfortably.

ANOTHER DIVISION of the earth is into *the three ſpheres*—according to the ſeveral poſitions of the equator with reſpect to the horizon.

1. When the equator is at right angles to the horizon, it is called a *Right Sphere*. The poles of the Globe are then in the horizon; and the equator and all the circles of the ſun's daily motion, parallel to it, are divided, by the horizon, into two equal parts. Thoſe who live at the equator are, therefore, in a right ſphere; and with them, the days and nights are always equal.

2. When the equator is parallel to the horizon, it is called a *Parallel Sphere*. The poles of the Globe are, then, the one in the zenith, the other in the nadir; all the circles of the ſun's daily motion are parallel to the horizon; and half of the ecliptic is always above, and the other half below it. The inhabitants of the poles (if any) are, therefore, in a parallel ſphere; they ſee the ſun and all the heavenly bodies move round them in circles parallel to the horizon; and their day and night continue each half a year.

3. When the equator is oblique to the horizon, it is ſaid to be an *Oblique Sphere*. The poles of the Globe are then the one elevated above, and the other depreſſed below, the horizon, in an angle leſs than a

right angle: and all the circles of the ſun's daily motion (except the equator) are divided, by the horizon, into two unequal parts. The inhabitants of every part of the earth, between the equator and the poles, are, therefore, in an oblique ſphere; and their days and nights are always of unequal length, except only at the equinoxes.

THE INHABITANTS of the Earth are, again, diſtinguiſhed into the Antœci, the Periœci, and the Antipodes—according to their relative ſituation with reſpect to each other.

1. The Antœci are thoſe who live under the ſame meridian, and in equal latitude, one on the *north* and the other on the *ſouth* ſide of the equator. They have the ſame hours of the day, but oppoſite ſeaſons of the year.

2. The Periœci are thoſe who live in oppoſite meridians, and in the ſame parallel of latitude. They have oppoſite hours of the day, but the ſame ſeaſons of the year.

3. The Antipodes are thoſe who live in oppoſite meridians, and in equal latitudes, one north the other ſouth. They have oppoſite hours of the day, and oppoſite ſeaſons of the year.

QUESTIONS.

What are the five zones, and whence is the name derived? What is the ſituation of the torrid zone, and from what miſtaken opinion was this name given to it? What is the ſituation of the two temperate zones, and why are they ſo called? What is the ſituation of the two frigid zones, and why are they ſo called?—What other diviſion of the Earth is given? What is a right ſphere? What is the poſition of the poles, and how are the circles of the ſun's daily motion divided by the horizon, in a right ſphere? What inhabitants of the Earth are in a right ſphere, and what is obſerved of the length of their days and nights? What is a parallel ſphere? What is the poſition of the poles, and of all the circles of the ſun's daily motion, in a parallel ſphere? How is the ecliptic divided by the horizon, in a parallel ſphere? In what part of the Earth would the inhabitants be in a parallel ſphere, and what is the length of the day and night in that part? What is an oblique ſphere? What is the poſition of the poles, and how are the circles of the ſuns daily motion divided by the horizon, in an oblique ſphere? What inhabitants of the earth are in an oblique ſphere and what is obſerved of the length of their days and nights?—What is the other diviſion of the earth? What are the Antœci, and what is obſerved of their hours of the day and ſeaſons of the year? What are the Periœci, and what is obſerved of their hours of the day and ſeaſons of the year? What are the Antipodes, and what is obſerved of their hours of the day and ſeaſons of the year?

LESSON XIII.

GEOGRAPHICAL OBSERVATIONS.

1. At all places between the tropics, the ſun is *vertical*, or in the zenith, twice every year; and at all places, which lie under the tropics, once every year. For there are two points of the ecliptic equal to the latitude of every place, between the tropics; and one point of the ecliptic equal to the latitude of all places, under the tropics: conſequently the ſun muſt be vertical at the former places *twice*, and at the latter *once*, every year.

2. The ſun is never vertical to any place in either of the temperate or frigid zones. For no part of the ecliptic extends beyond the tropics.

3. At the equator, all places have their days and nights of equal length (12 hours each), *at all times of the year*. For, there, the equator and all the circles of the ſun's daily motion, parallel to it, are divid-

ed, by the horizon, into two equal parts: conſequently, every 24 hours, the ſun muſt continue half the time *above* the horizon, and the other half *below* it—i. e. day and night muſt be always equal.

4. At the poles, the day and night continue each half a year. For, there, one half the ecliptic is always *above* the horizon, and the other half *below* it.

5. At all places between the equator and the poles, the days and nights are of equal length when the ſun is in the equinoctial. For in every poſſible elevation of the pole, ſhort of 90°, the equinoctial is divided, by the horizon, into two *equal* parts.

6. In all places between the equator and the polar circles, the days and nights are never of equal length, but when the ſun is in the equinoctial. For, in every other part of the ecliptic, the circles of the ſun's daily motion are divided, by the horizon, into two *unequal* parts.

7. The nearer any place is to the equator, the leſs is the difference—and the more remote the place, the greater the difference—in the length of the days

and nights, at that place. For, the circles of the ſun's daily motion are divided, by the horizon, more *equally* in the *former* caſe, and more *unequally* in the *latter*.

8. In all places in the ſame parallel of latitude, however long or ſhort the day and night be at any one of theſe places, at any time of the year, it is then of the *ſame length* at all the reſt. For, at all theſe places—every circle of the ſun's daily motion is divided, by the horizon, into portions, all equal to one another: ſo that, at any given time, the ſun will be to all theſe places, equally long above and below the horizon—i. e. the days and nights will be of the ſame length to all of them.

QUESTIONS.

What is the firſt obſervation with reſpect to the verticality of the ſun—and how does the truth of it appear? What is the ſecond obſervation—and how does the truth of it appear? What is the obſervation with reſpect to the length of day and night at the equator—and how does the truth of it appear? What is the obſervation with reſpect to the length of day and night at the poles—and how does the truth of it appear? What is the obſervation with reſpect to the length of day and night when the ſun is in the equinoctial—and how does the truth of it appear? What is the obſervation with reſpect to the length of day and night when the ſun is not in the equinoctial—and how does the truth of it appear? What is the obſervation with reſpect to the different lengths of day and night, at different places—and how does the truth of it appear? What is the obſervation with reſpect to the length of day and night, at places in the ſame parallel of latitude—and how does the truth of it appear?

LESSON XIV.

GEOGRAPHICAL OBSERVATIONS, CONTINUED.

9. In all places in the northern hemiſpheres, from the equator to the polar circles, the longeſt day and the ſhorteſt night are when the ſun is in the *northern tropic;* for no circle of the ſun's daily motion is ſo much above the horizon, and ſo little below it, as this: but the ſhorteſt day and the longeſt night are when the ſun is in the *ſouthern tropic;* for no circle of the ſun's daily motion is ſo little above, the horizon, and ſo much below it, as this. In the ſouthern hemiſphere the contrary.

10. At the polar circles, the longeſt day and the longeſt night are 24 hours each. For, there, the nearer tropic is entirely above, and the farther tropic entirely below, the horizon: ſo that, for the ſpace of 24 hours, the ſun continues above the horizon, without ſetting; and likewiſe, for the ſame ſpace of time, continues below it, without riſing.

11. Within the frigid zones, the longeſt day and the longeſt night are each of them more than 24 hours. For, there, ſeveral of the circles of the ſun's daily motion are always above, and as many always below, the horizon: ſo that the ſun muſt continue above the horizon, and, at oppoſite times of the year, below it, for more than 24 hours together.—And the nearer any place is to the poles, the more of theſe circles are entirely above or below the horizon; conſequently, the longer is the ſun's continued preſence or abſence to that place.

12. The longeſt day and the longeſt night, in any part of the torrid and temperate zones, are leſs than 24 hours. For, there, no circle of the ſun's daily motion is entirely above, nor any entirely below, the horizon; and therefore the ſun will riſe and ſet every 24 hours within theſe zones.—And the more remote any place is from the equator, ſo much the larger portion of the nearer tropic is always above the horizon; conſequently, the longer is the longeſt day in that place.

13. At different places, the hour of the day differs in proportion to the difference of longitude;

15°. of longitude making the difference of one hour in time, and 15 of longitude one minute of time. And the ſun is ſeen, at any given place, ſooner than at places which lie to the *weſt* of it, and later than at places which lie to the *eaſt* of it. For, as the ſun appears to move, from eaſt to weſt, round the earth, which is 360°. of longitude, in 24 hours; its daily apparent motion muſt be at the rate of 15°. of longitude (the 24th part of 360°.) in one hour, and 15 of longitude in one minute. Conſequently, at any given place, the ſun will be ſeen in the meridian one hour, or one minute, *ſooner* than at places 15°. or 15 of longitude *weſtward*; and one hour, or one minute, *later* than at places 15°. or 15 of longitude *eaſtward*.

14. All places on the earth do equally enjoy the benefit of the ſun in *reſpect of time*, and are equally deprived of it. For, at the poles, the day and night continue each half a year; at the equator, the day and night is always 12 hours each; and, in all the intermediate places, the days are always as much longer than 12 hours in ſummer, as they are ſhorter in winter: in the whole courſe, therefore, of every year, the ſun is ſeen, at all places *an equal ſpace of time*.

QUESTIONS.

What is the obſervation with reſpect to the longeſt and ſhorteſt days in the northern and ſouthern hemiſpheres—and how does the truth of it appear? What is the obſervation with reſpect to the longeſt day and night at the polar circles—and how does the truth of it appear? What is the obſervation with reſpect to the longeſt day and night within the frigid zones—and how does the truth of it appear? What it the farther obſervation with reſpect to the longeſt day within the frigid zones—and how does the truth of it appear? What is the obſervation with reſpect to the longeſt day and night in the torrid and temperate zones—and how does the truth of it appear? What is the farther obſervation with reſpect to the longeſt day in the torrid and temperate zones—and how does the truth of it appear? What is the obſervation with reſpect to the hour of the day at different places—and how does the truth of it appear? What is the concluding obſervation—and how does the truth of it appear?

LESSON XV.

OF THE ATMOSPHERE. OF WINDS.

THE AIR, with which the earth is ſurrounded, and which is a part of itſelf, is called the *Atmoſphere.* It extends to the height of ſeveral miles above the ſurface of the earth: and, by reflecting the ſun's rays, it makes the whole heavens appear luminous *before* the ſun riſes and *after* it ſets; ſo that light and darkneſs do not come on ſuddenly. This illumination of the atmoſphere is called *Twilight.* All places have the benefit of it, when the ſun is not more than 18° below their horizon. And as there is one part of the year, in the latitude of London, when the ſun does not deſcend 18° below the horizon, *viz.* from 26 *May* to 18 *July*, there muſt then be continual twilight.

THE WIND is the motion or current of the air upon the ſurface of the Globe, occaſioned by the heat of the ſun.

Within and near the tropics, winds are more regular and certain than elſewhere; becauſe, there, the atmoſphere is more ſtrongly and regularly influenced by the ſun's rays.

In the Atlantic, the Pacific, and Southern oceans, between the latitudes of 30° north and 30° ſouth, but at a diſtance from the ſhores, there are *conſtant eaſterly* winds, which are called the General Trade Winds. It is only, however, under the Equator that theſe winds blow due Eaſt: for, on each ſide of it, they are found to vary from the Eaſt point, ſo as to become north-eaſt on the northern ſide, and ſouth-eaſt on the ſouthern. Theſe winds are denoted on the terreſtrial globe by ſmall arrows, placed in the direction of the winds.

A little beyond the limits of the Trade Winds, on the north ſide, there is obſerved to be generally a weſt or ſouth-weſt wind.

In the Indian Ocean, there are *periodical* winds, called *Monſoons*. Theſe winds blow ſix months in one direction, and ſix months in the oppoſite direction. The *change* of the Monſoons is near the vernal and autumnal equinoxes; and is attended with violent ſtorms of wind, thunder, and lightnings. The Monſoons are denoted on the Globe by twelve arrows.

Beyond the limits of the trade winds, in all the northern and ſouthern parts of the World, the courſe of the wind is variable and uncertain.

QUESTIONS.

What is the Atmoſphere, and what is the height of it? What is the twilight, and when is the benefit of it enjoyed in any part of the earth? In what part of the year is there continual twilight in 51°$\frac{1}{2}$ N. L? What is the Wind? What is the general account of the Winds within and near the tropics? What are the General Trade Winds? How are theſe Winds denoted on the Globe? What is the uſual courſe of the Winds near the north limits of the Trade Wind? What are the Monſoons? What circumſtances attend the change of the Monſoons? How are the Monſoons denoted upon the Globe? What is the general account of the Winds beyond the limits of the Trade Winds?

LESSON XVI.

OF THE CELESTIAL GLOBE.

The Celeſtial Globe is an artificial repreſentation of the heavens—the fixed ſtars being drawn upon it in their natural order and ſituation; divided into conſtellations, or ſyſtems of ſtars; and diſtinguiſhed by the names of men, beaſts, birds, *&c.* which the fancy of the ancients or the moderns has given to them. There are ſome ſtars which are not included in any conſtellations; and theſe are called *unformed ſtars.*

The fixed ſtars are alſo divided, by aſtronomers, into *ſix claſſes*, according to their different apparent magnitudes. The largeſt ſtars are called "ſtars of the firſt magnitude;" and the leaſt, that are viſible to the naked eye, "ſtars of the ſixth magnitude."

Thoſe ſtars which are only viſible by the aid of glaſſes are called *teleſcopic ſtars.*

The Celeſtial Globe cannot be ſaid to be ſo juſt a repreſentation of the Heavens, as the terreſtrial Globe is of the Earth; becauſe the ſtars are drawn upon a *convex* ſurface, yet they naturally appear in a *concave* one. But ſuppoſe the Globe were made of *glaſs*, then, to an eye placed in the centre, the ſtars drawn upon it would appear in a concave ſurface, juſt as they do in the heavens.

The *latitude* of any heavenly body is its diſtance from the ecliptic, either north or ſouth. The *longitude* of any heavenly body is its diſtance from the firſt of Aries, reckoned upon the *ecliptic*— The ſun has no latitude, being always in the ecliptic; nor is it uſual to ſpeak of its longitude but of "its place in the ecliptic."

The *declination* of any heavenly body is its diſtance from the equinoctial, either north or ſouth.

The *right aſcention* of any heavenly body is its diſtance from the firſt of Aries, reckoned upon the *equinoctial.*

The *altitude* or *depreſſion* of any heavenly body is its diſtance from the horizon, above or below it.

The *azimuth* of a heavenly body is its diſtance, eaſt or weſt, from the meridian of any place meaſured on the horizon.

The *amplitude* of a heavenly body is its diſtance, at the time of riſing or ſetting, from the eaſt or weſt point, either northward or ſouthward.

If a heavenly body riſes or ſets when *the ſun riſes*, it is ſaid to riſe or ſet *coſmically;* if it riſes or ſets when *the ſun ſets*, it is ſaid to riſe or ſet *achronically;* when it *approaches* ſo near to the ſun as to become *inviſible*, or *recedes* ſo far from it as to become *viſible*, it is ſaid to riſe or ſet *heliacally*.

QUESTIONS.

What is the celeſtial Globe? How are the fixed ſtars divided and diſtinguiſhed from one another? What are the unformed ſtars? What is the other diviſion of the ſtars? What are the largeſt, and what are the leaſt ſtars called? What are the teleſcopic ſtars? In what reſpects does the celeſtial globe fail of being a true repreſentation of the heavens? On what ſuppoſition would the celeſtial globe be a juſt repreſentation of the heavens? What is the latitude and longitude of a heavenly body? What is the declination and right aſcenſion of a heavenly body? What is the altitude and depreſſion of any heavenly body? What is the azimuth of a heavenly body? What is the amplitude of a heavenly body? When is a heavenly body ſaid to riſe and ſet coſmically—achronically—and helliacally?

LESSON XVII.

OF THE NORTHERN CONSTELLATIONS, &c.

The Conſtellations, drawn upon the celeſtial globe, are divided into northern and ſouthern—beſides the 12 zodiacal ſigns which lie in the middle between both—in all about 80 conſtellations.

THE FOLLOWING, are the names of the 36 Northern Conſtellations, with the number of ſtars obſerved in each by Flamſteed, and other Aſtronomers.

1. *Conſtellations that are always or for the moſt part above the horizon in the latitude of London..*

1. Urſa Minor. *The little Bear*	24
2. Draco. *The Dragon*	80
3. Cepheus	35
4. Lacerta. *The Lizard*	
5. Caſſiopeia	55

6. Perſeus		59
7. Caput Meduſœ.	*Meduſa's Head*	
8. Camelopardalus.	*The Camelopard*	58
9. Lynx.	*The Lynx*	44
10. Urſa Major.	*The Great Bear*	87
11. Cor Caroli.	*Charles' Heart*	

2. *Conſtellations that riſe and ſet in the latitude of London northward of the eaſt and weſt points.*

1. Leo Minor.	*The Little Lion*	53
2. Coma Berenices.	*Berenice's Hair*	43
3. Aſterion and Chara.	*The Grey hounds*	25
4. Boötes		54
5. Corona Borealis.	*The Northern Crown*	21
6. Hercules		113
7. Cerberus.	*The Three-Headed Dog*	9
8. Lyra.	*The Harp*	21
9. Cygnus.	*The Swan*	81
10. Vulpecula et Anſer.	*The Fox and Gooſe*	35
11. Sagitta.	*The Arrow*	
12. Delphinus.	*The Dolphin*	18
13. Pegaſus.	*The Flying Horſe*	89
14. Andromeda		66
15. Triangulum Boreale.	*The North Triangle*	16
16. Muſca.	*The Fly*	
17. Auriga.	*The Waggoner*	66

3. *Conſtellations that riſe and ſet at or near the eaſt and weſt points.*

1.	Mons Mænalus.	*The Hill Mænalus*	
2.	Serpens.	*The Serpent*	64
3.	Serpentarius.	*The Serpent-Bearer*	74
4.	Scutum Sobieſki.	*Sobeiſki's Shield*	8
5.	Taurus Poniatowſki.	*Poniatowſki's Bull*	
6.	Antinous		34
7.	Aquila.	*The Eagle*	12
8.	Equulus.	*The Colt*	10

THE NAMES of the 12 zodiacal Signs are given in Leſſon V. The number of ſtars obſerved in each of them are as follows.

1.	Aries.	*The Ram*	66
2.	Taurus.	*The Bull*	141
3.	Gemini.	*The Twins*	85
4.	Cancer.	*The Crab*	83
5.	Leo.	*The Lion*	95
6.	Virgo.	*The Virgin*	110
7.	Libra.	*The Balance*	51
8.	Scorpio.	*The Scorpion*	44
9.	Sagittarius.	*The Archer*	69
10.	Capricornus.	*The Goat*	51
11.	Aquarius.	*The Waterman*	108
12.	Piſces.	*The Fiſhes*	113

QUESTIONS.

HOW are the conſtellations divided? How many conſtellations are uſually drawn upon the Globe?—How many northern conſtellations are there?—What are the 6 firſt conſtellations that are always above the horizon in the latitude of London? What are the 5 laſt?—What are the 6 firſt conſtellations which riſe northwards of the eaſt point? What are the 6 ſecond? What are the 5 laſt?—What are the 4 firſt conſtellations which riſe at or near the eaſt point? What are the 4 laſt?——What are the 12 zodiacal ſigns?

LESSON XVIII.

OF THE SOUTHERN CONSTELLATIONS.

The 32 Southern Conſtellations may be diſtinguiſhed into thoſe which are viſible, and thoſe which are not viſible, in the lat. of London—beſides the new ſouthern conſtellations.

1. *Conſtellations viſible in the lat. of London.*

1.	Piſcis Auſtralis. *The Southern Fiſh*	24
2.	Cetus. *The Whale*	97
3.	Eridanus. *The River Po*	84
4.	Orion.	78
4.	Lepus. *The Hare*	19
6.	Canis Major. *The Great Dog*	31
7.	Monoceros. *The Unicorn*	31
8.	Canis Minor. *The Little Dog*	14
9.	Hydra. *The Hydra*	60
10.	Sextans. *The Sextant*	41
11.	Crater. *The Cup*	31
12.	Corvus. *The Crow*	9

2. *Conſtellations that are always, or for the moſt part, below the horizon in the lat. of London.*

1.	Argo Navis. *the Ship Argo*	64
2.	Crux. *the Croſs*	
3.	Centaurus. *the Centaur*	35
4.	Lupus. *the Wolf*	24
5.	Ara. *the Altar*	9
6.	Corona Auſtralis. *the South Crown*	12

3. *New Southern Conſtellations.*

1.	Columba Noachi. *Noah's Dove*	10
2.	Robur Carolinum. *the Royal Oak*	12
3.	Apis. *the Bee*	4
4.	Triangulum Auſtrale. *The South Triangle*	5
5.	Apus. *the Bird of Paradiſe*	11
6.	Pavo. *the Peacock*	14
7.	Indus. *the Indian*	12
8.	Grus. *the Crane*	13
9.	Phœnix. *the Phœnix*	13
10.	Toucan. *the American Gooſe*	9
11.	Hydrus. *the Water Snake*	10
12.	Dorado. *the Sword Fiſh*	6
12.	Piſces Volans. *the Flying Fiſh*	8
14.	Chamœleon. *the Cameleon*	10

⁂ The number of the fixed ſtars is unknown. The catalogue publiſhed by Flamſteed, which includes many teleſcopic ſtars, contains 3000: but from the late diſcoveries of Dr. Herſchel, it appears that the number of the ſtars exceeds all power of calculation. This celebrated Aſtronomer has ſhewn—that many ſtars, which to the eye, or through ordinary glaſſes, appear *ſingle*, do in fact conſiſt of two or more ſtars—that the luminous parts of the heavens, called the *milky way*, conſiſts of fixed ſtars too ſmall to be ſeen, but by the help of glaſſes—and that the bright ſpots in the heavens, called *nebulæ*, are alſo compoſed of ſmall ſtars, placed ſo cloſe that the naked eye, or even ordinary teleſcopes, cannot diſcern them. But the number of ſtars diſcoverable in either hemiſpheres, by the naked eye, is not above a thouſand.

QUESTIONS.

How many ſouthern conſtellations are there—and how are they divided?—What are the 6 firſt conſtellations viſible in the latitude of London? What are the 6 laſt?—What are the 6 conſtellations not viſible in the latitude of London?—What are the 7 firſt of the new ſouthern conſtellations? What are the 7 laſt?—What is the number of the fixed ſtars in Flamſteed's Catalogue? What is the account of Dr. Herſchel's diſcoveries? What is the milky way? What are the nebulœ?—What is the number of ſtars diſcoverable by the naked eye?

LESSON XIX.

OF THE NAMES AND SITUATIONS OF THE PRINCIPAL FIXED STARS.

Some of the principle fixed ſtars are diſtinguiſhed by particular names: the reſt are denoted by the letters of the Greek Alphabet; the largeſt ſtar in every conſtellation being marked by the firſt letter, the ſtar of the next magnitude by the ſecond letter, and ſo on. By this contrivance the place of any particular ſtar in the heavens may be found with the greateſt eaſe and preciſion.

The names and ſituations of the principal fixed Stars are as follows:—

	Magn.
Albiero, *in the beak of Cygnus*	3
Altair, *in Aquilia*	2
Aldebaran, or the Bull's eye, *in Taurus*	1
Algenib, *in the right ſide of Perſeus*	2
Algol, *in Caput Meduſæ*	2

	Magn.
Alioth, *firſt in the tail of Urſa Major*	2
Almaac, *in the leſt heel of Andromeda*	2
Alpheta, *in Corona Borealis*	2
Areto Baſ Aben, *in the head of Draco*	2
Arcturus, *in the ſkirts of Boötes*	1
Bellatrix, *in the leſt ſhoulder of Orion*	2
Betelgueſe, *in the right ſhoulder of Orion*	1
Benenaez, *laſt in the tail of Urſa Major*	2
Caſtor, *in Gemini*	2
Capella, or the Kid, *on the leſt ſhoulder of Auriga*	1
Charles' Wain, 7 *remarkable ſtars in Urſa Major,* 4 *in the body forming a ſquare, and* 3 *in the tail. The two ſtars in the ſquare, fartheſt from the tail, are the pointers to the North Pole*	2
Cor Hydra, or the Hydra's heart, *in Hydra*	1
Cor Leonis, or the Lion's heart, *in Leo Major*	1
Cor Scorpionis, or the Scorpion's heart, *in Scorpio*	1
Deneb, *in the tail of Leo Major*	2
Dubhe, *the northernmoſt ſtar in the ſquare of Urſa Major*	2
Enif, *in the noſe of Pegaſus*	3
Formahaut, *near the mouth of Piſcis Auſtralis*	1
Hyades, 5 *ſtars in the face of Taurus*	
Korkab, *in the neck of Urſa Minor*	3

	Magn.
Markab, *in the right wing of Pegaſus*	2
Mirach, *in the girdle of Andromeda*	2
Menkar, *by the mouth of Cetus*	1
North Pole Star, *in the extremity of the tail of Urſa Minor*	2
Orion's Belt, 3 *remarkable ſtars in Orion*	2
Pleiades, 7 *remarkable ſtars on the back of Taurus*	
Pollux, *in Gemini*	2
Procyon, *in the body of Canis Minor*	1
Ras Algethi, *in the head of Hercules*	3
Ras Alhagus, *in the head of Serpentarius*	2
Rigel, *in the left foot of Orion*	1
Scheat, *in the right leg of Pegaſus*	2
Schedar, *in Caſſiopeia*	3
Sirius, or the Dog Star, *in the mouth of Canis Major*	1
Spica, *in the left hand of Virgo*	1
Vendemiatrix, *in the left wing of Virgo*	2
Vega, *in the north weſt corner of Lyra*	2

QUESTIONS.

How are the ſtars in each conſtellation diſtinguiſhed?—What is the ſituation of—Arcturus—Capella — Algol — Enif — Benenaez — Orion's Belt—Charles' Wain—North Pole Star—Caſtor —Almaac — Cor Hydræ — Scheat — Kokab — Pollux—Bellatrix—Sirius—Vega — Albiero — Rigal — Spica — Arato-Baf-Aben — Pleiades — Formahaut — Ras Algethi — Alioth — Schedar — Mirach — Dubhe — Cor Scorpionis — Menkar — Aldebaran—Beltagueſe—Ras Alhagus—Alpheta —Markab—Altair—Deneb—Algenib—Hyades —Cor Leonis—Vindemiatrix—Procyon? What are the names of the ſtars of the firſt magnitude in —Boötes—Taurus—Auriga—Scorpio—Hydra—Cetus — Piſcis Auſtralis — Canis Minor — Canis Major—in Orion's foot? What are the names of the ſtars of the ſecond magnitude in — Aquila—Perſeus — Caput Meduſœ — Corona Borealis — Draco—Serpentarius—Square of Urſa Major—Lyra? What are the names of the ſtars of the third magnitude in—Albiero—Pegaſus—Hercules —Caſſiopeia? What are the names of the two principal ſtars in — Urſa Minor — Leo Major — Andromeda—Virgo—Pegaſus—tail of Urſa Major —ſhoulders of Orion? What are the names of— the 3 remarkable ſtars in Orion—the 5 in the face of Taurus—and the 7 on the back of Taurus?—What ſtars are called the pointers to the North Pole?

LESSON XX.

PROBLEMS PERFORMED BY THE TERRESTRIAL GLOBE.

PROB. I. *To find the latitude and longitude of any given place.* Bring the given place to the graduated edge of the braſs meridian—the degree of the meridian directly over the place is its latitude—and the degree of the equator cut by the braſs meridian is its longitude.

PROB. II. *The latitude and longitude of any place being known to find the place.* Bring the given longitude to the braſs meridian—then look for the given latitude—and under that degree of the meridian is the place required.

PROB. III. *Any place being given to find all thoſe places which have the ſame latitude.* Bring the given place to the braſs meridian—note the degree of latitude—then all places, which paſs under the ſame degree of the meridian, have the ſame latitude.

PROB. IV. *Any place being given to find all thoſe places which have the ſame longitude.* Bring the given place to the braſs meridian—then all thoſe places, which lie under the ſame half of the meridian from the north to the ſouth poles, have the ſame longitude.

PROB. V. *To find the difference of latitude between any two places.* Find the latitude of each place—and note the degrees between the two latitudes on the braſs meridian—which is the difference required.

PROB. VI. *To find the difference of longitude between any two places.* Find the longitude of each place—and note the degrees between the two longitudes on the equator—which is the difference required.

PROB. VII. *To find what number of miles are equal to a degree of longitude in any given latitude.* Lay the quadrant of altitude, parallel to the equator, between any two meridians, in the given latitude; and obſerve the number of degrees intercepted between them—multiply that number of degrees by 60, which reduces them to geographical miles—divide the product by the number of degrees intercepted between the ſame meridians noted on the equator—and it will give the length of the degree of longitude ſought.

QUESTIONS.

How is the latitude and longitude of any place found? The latitude and longitude being given, how is the place found? How are all thoſe places found which have the ſame latitude as any given place? How are all thoſe places found which have the ſame longitude as any given place? How is the difference of latitude between any two places found? How is the difference of longitude between any two places found? How is the number of miles equal to a degree of longitude in any given latitude found?

Queſtions for the exerciſe of the learner, with the Anſwers.

QUEST. 1. What are the latitudes and longitudes of Bergen—Barbadoes—Lima in Peru—the Cape of Good-Hope? *ANS.* 12° S. Lat. 77° W. Long.—13° N. Lat. 58°½ W. Long.—34°½ S. Lat. 18°½ E. Long. — 60° N. Lat. 6° E. Long. *QUEST.* 2. What are the places ſituated in 5° 48 N. Lat. 55°½ W. Long.—34°½ S. Lat. 18°½

E. Long.—52°½ N. Lat. 13°½ E. Long.—12° S. Lat. 38°½ W. Long.—*ANS.* Cape of Good Hope —Surinam—Berlin—St. Salvador—*QUEST.* 3. What places are in the ſame latitude as London? *ANS.* Southern parts of Holland and the northern parts of Flanders, Weſtphalia Upper Saxony, Sileſia, middle parts of Poland, ſouthern parts of Ruſſia, and Siberia iſland of Sangaleen, ſouth point of Kamſchatka, unknown parts of North America, north point of Canada, counties of Kerry and Cork in Ireland, &c. &c. *QUEST.* 4. What places are in the ſame longitude as London? *ANS.* Weſtern parts of France, eaſtern parts of Spain, Barbary, unknown parts of Africa, &c. &c. *QUEST.* 5. What is the difference in the latitudes of Paris and Madrid—of Amſterdam and Batavia —Cape Farewell and Cape Horn? *ANS.* 58° 32 —8° 25 —116° *QUEST.* 6. What is the difference in the longitudes of London and Canton—of Rome and Conſtantinople—Cape Finiſterre and Cape Comorin? *ANS.* 16° 24 —87° 22 —113° *QUEST.* 7. What number of miles are equal to a degree of longitude in latitude 21° —28°—40°—60°—70° *ANS.* 53°—46°—56—15½—30—geographical miles.

LESSON XXI.

PROBLEMS PERFORMED BY THE TERRESTRIAL GLOBE.

PROB. VIII. *To find the Antœci, Periœci, and Antipodes to any given place.* 1. Bring the given place to the braſs meridian and note the latitude—under the ſame degree of latitude, in the oppoſite hemiſphere, the place of the Antœci will be found. 2. While the given place is under the braſs meridian, ſet the hour index to the upper 12 and turn the Globe till it points to the lower 12—then under ſame the latitude as the given place in the ſame hemiſphere, the ſituation of the Periœci will be found. 3. While the Globe is in this laſt poſition, the place of the Antipodes will be found under the ſame degree of latitude with the given place, but in the oppoſite hemiſphere.

PROB. IX. *To repreſent the three ſpheres.* 1. Move the meridian till it coincides with the horizon—the globe then repreſents a parallel ſphere. 2. Move the meridian till the two poles are in the horizon—then the Globe repreſents a right ſphere. 3. Elevate either of the poles to any degree leſs than 90°.—the Globe in this poſition repreſents an oblique ſphere.

PROB. X. *To find the ſun's place in the ecliptic and its declination on any given day.* 1. Look for the given day on the wooden horizon—and againſt it is the ſign and degree of the ecliptic—in which the ſun is on that day. 2. Find the ſame ſign and degree on the ecliptic—bring it to the braſs meridian—and the degree over it ſhews the ſun's declination at the given time.

PROB. XI. *To rectify the globe to the latitude of any place, the zenith, and the ſun's place.* 1. If the given place be in the northern hemiſphere, raiſe the north pole above the north point of the horizon; and let the horizon interſect the meridian exactly in the degree of the given latitude, counted below the elevated pole—if the place be in the ſouthern hemiſphere, raiſe the ſouth pole in the ſame manner above the ſouth point of the horizon—the globe is then adjuſted to the latitude. 2. Next, let the quadrant of altitude be ſcrewed on the meridian exactly in the given degree of latitude, counting from the equator towards the elevated pole—the globe is then rectified for the zenith. 3. Find the ſun's place in the ecliptic—bring it to the braſs meridian—and ſet the hour index to 12 at noon—the globe is then rectified for the ſun's place.

PROB. XII. *To find the diſtance between any two places.* Lay the quadrant of altitude over both the places—note the number of degrees intercepted between them—multiply that number by 60, which reduces it into geographical miles—or by 70, (or more exactly by 69½,) which gives the diſtance required in Engliſh miles.

QUESTIONS.

How are the Antœci, Periœci, and Antipodes of any place found? How are the three ſpheres repreſented by the Globe? How is the ſun's place in the ecliptic and its declination found? How is the globe rectified, for the latitude, the zenith, and and the ſun's place? How is the diſtance between any two places found?

Queſtions for exerciſe, &c.

QUEST. I. What is the place of the Antœci, Periœci, and Antipodes of London? *ANS.* In the Southern Ocean 17° S. W. of the Cape of Good Hope is the place of the Antœci—that of the Periœci is between the coaſts of N. America and Kamſchatka—and in the Southern Ocean S. of New Zealand is the place of the Antipodes.

QUEST. 2. What is the ſun's place in the ecliptic on 25 Dec.—21 May—14 July? *ANS.* 4° of Capricornus—30° of Taurus—22° of Cancer.

QUEST. 3. What is the ſun's declination 10 Feb.—6 April—22 June? *ANS.* $14^\circ\frac{1}{4}$ S. D.—$6^\circ\frac{1}{2}$ N. D.—$23^\circ\frac{1}{2}$ N. D. *QUEST.* 4. What is the diſtance in geographical and Engliſh miles between London and Vienna—Cork and Philadelphia—Plymouth and Gibralter? *ANS.* 660 geographical or 781 Engliſh—2820 geographical or 3243 Engliſh—840 geographical or 973 Engliſh miles.

LESSON XXII.

PROBLEMS PERFORMED BY THE TERRESTRIAL GLOBE.

PROB. XIII. *To find all thoſe places which are at the ſame diſtance from any given place.* Bring the given place to the meridian—rectiſy the Globe for its latitude and zenith—and move the quadrant of altitude round the globe—then all thoſe places which paſs under the ſame degree of the quadrant have the ſame latitude.

PROB. XIV. *To find the bearing of any two places.* Rectify the globe for the latitude and the zenith of one of the places—and let the quadrant of altitude paſs directly over the other—the degrees on the horizon, intercepted between the meridian and the quadrant, will ſhew the bearing of the ſecond place with reſpect to the firſt.

PROB. XV. *The time of the day being given at one place, to find the correſponding time at any other place.* Bring the place at which the time is known to the meridian—ſet the hour index to the given time—and turn the Globe till the other place comes to the meridian—the hour index will then point to the time required.

PROB. XVI. *To find the hour of ſun riſing and ſun ſetting, and the length of the day and night, at any given time, in any given latitude, between the equator and the polar circle.* 1. Rectify for the latitude and the ſun's place, then bring the ſun's place to the eaſtern part of the horizon—and the hour index will point to the time of ſun riſing—next bring the ſun's place to the weſtern part of the horizon—and the hour index will then point to the time of ſun ſetting. 2. The hour of ſun ſetting, doubled, gives the length of the day; and the hour of ſun riſing, doubled, gives the length of the night.

PROB. XVII. *To find the length of the longeſt and ſhorteſt day and night, in any given latitude between the equator and the polar circles.* 1. Rectify for the latitude—bring the neareſt tropical point (firſt of Cancer, if the place be in the northern hemiſphere) to the eaſtern part of the horizon, and ſet the hour index to 12—then bring the ſame tropical point to the weſtern part of the horizon, and obſerve the number of hours which the index has paſſed over—which is the length of the longeſt day—and that number, ſubtracted from 24, gives the length of the ſhorteſt night. 2. Let the fartheſt tropical point be brought, in the ſame manner, to the eaſtern and weſtern parts of the horizon—and thus the length of the ſhorteſt day and longeſt night, in the given latitude, will be found.

QUESTIONS.

How are all thoſe places found which are at the ſame diſtance from any given place? How is the bearing between any two places found? If the time of the day be given at one place, how is the correſponding time at any other place found? How is the hour of the ſun's riſing and ſetting, and the length of the day and night, at any given time, in any given latitude, leſs than 66°½ found? How is the length of the longeſt and ſhorteſt day and night, in any given latitude leſs than 66°½, found?

Queſtions for exerciſe, &c.

QUEST. 1. What places are at the ſame diſtance from London as Bergen? *ANS.* Gottenburg, Cammin, Hanover, Prague, Trent, Genoa, Toulon, Oviedo, &c. *nearly.* *QUEST.* 2. What are the bearings between the Lizard Point and Barbadóes—Paris and Naples—Madrid and Mexico? *ANS.* 69 S. W.—48 S. E.—70 N. W. *QUEST.* 3. When is it noon at London, what hour is it at Botany Bay? *ANS.* 10 at night. *QUEST.* 4. When it is 6 in the morning at Kingſton in Jamaica what hour is it at Bombay? *ANS.* 4 in the afternoon. *QUEST.* 5. When it is 1 in the afternoon at Dublin what is the hour at Boſton in New-England? *ANS.* $45^{m.}$ paſt 8 in evening. *QUEST.* 6. What is the time of ſun riſing and ſetting, and the length of the day and night at London, 20 April—at Gibralter 20 Dec—at Madraſs 23 Aug. —and at Bourbon Iſle 1 Dec.? *ANS.* Sun riſes, in the firſt place, at 4¾ hours and ſets at 7¼—the day is then 14½ hours and the night 9½—in the ſecond place it riſes 15 minutes paſt 7 and ſets $45^{m.}$ paſt 4; the day is 9½ and the night 14½—in the third place, ſun riſes at $45^{m.}$ paſt 5 and ſets $15^{m.}$ paſt 6; the day is 12½ and the night 11½ hours—in the laſt place ſun riſes at ¼ paſt 5 and ſets ¾ paſt 6; the day is 13½ hours and the night 10½. *QUEST.* 7. What is the length of the longeſt and ſhorteſt day and night at the Canary Iſles—at Madrid—at York—at Peterſburgh? *ANS.* 14 hours L. D. and N. 10 S. D. and N.—15 hours L. D. and N. 9 S. D. and N.—17 hours L. D. and N. 7 S. D. and N.—19 hours L. D. and N. 5 hours S. D. and N.

LESSON XXIII.

PROBLEMS PERFORMED BY THE TERRESTRIAL GLOBE.

PROB. XVIII. *To find the latitude in which the longeſt day is of any given length, leſs than* 24 *hours.* Bring either of the tropical points to the meridian, and ſet the hour index to 12—turn the Globe till the index has paſſed over half the number of hours given—then move the meridian till the tropical point touches the horizon—the horizon will, at the ſame time, cut the meridian in the degree of latitude ſought.

PROBLEM XIX. *To find the length of the longeſt day and the longeſt night at any given place within the frigid zones, and the time when the continual day-light and continual darkneſs begins and ends; alſo the time when the ſun riſes and ſets every* 24 *hours at that place.* 1. Rectify for the latitude —and turn the globe on its axis—then, if the given place be in the north frigid zone, obſerve the two points of the ecliptic, which exactly touch the north point of the horizon, where the braſs meridian cuts it—the days, which anſwer to the obſerved points, are the firſt and the laſt days of the ſun's continual appearance above the horizon of the given place—and the number of intermediate days (of 24 hours each) is the length of the longeſt day at that place. 2. Let the globe again be turned on its axis—and obſerve the two points of the ecliptic, which are are juſt below the ſouth point of the horizon—the days, which anſwer to the two obſerved points, are the firſt and the laſt day of the ſun's continual abſence from the given place — and the number of intermediate days is the length of the longeſt night at that place. 3. Note the time between the longeſt day and the longeſt night—which is the time when the ſun riſes and ſets every 24 hours, at the given place, as at other places on the globe. 4. If the given place be in the ſouth frigid zone—obſerve the two points of the ecliptic, which touch the ſouth point of the horizon for the longeſt day; and the two points, which touch the north point of the horizon, for the longeſt night—then proceed as before.

PROB. XX. *To find the latitude in which the longeſt day is of any given length, more than 24 hours.* Look on the horizon for the day of the month, which anſwers to the firſt of Cancer; and count, on either ſide of it, half the number of days in the given time—note the day at which the reckoning ends—find its correſponding degree on the ecliptic—and bring it to the meridian—then move the meridian till that degree of the ecliptic is in the horizon—and the elevation of the pole will ſhew the latitude ſought.

QUESTIONS.

How is the latitude found in which the longeſt day is of any given length leſs than 24 hours? How is the length of the longeſt day and night—the time of continual day-light and darkneſs—and the time in which the ſun riſes and ſets every 24 hours at any given place, within the frigid zone, found? How is the latitude found in which the longeſt day is of any given length more than 24 hours?

Queſtion for exerciſe, &c.

QUEST. 1. In what latitudes are the longeſt days 15 hours—16 hours—20 hours—and 21½ hours. *ANS.* 41° 22 —49°—63°¼—65° 21.

QUEST. 2. What is the length of the longeſt day and night—the time of continual day-light and darkneſs—and the time in which the ſun riſes and ſets every 24 hours—at the ſouth parts of James Iſland—at the north Cape of Lapland—and at the ſouth Cape of Spitzbergen? *ANS.* In James Iſland. L. D. and N. 2 months; day begins about 22 May, ends 21 July; night begins 21 Nov. ends 21 Jan. and between theſe two periods of perpetual day-light and darkneſs the ſun riſes and ſets every 24 hours. At Cape North L. D. and N. about 72 days; day begins 15 May ends 27 July; night begins 15 Nov. ends 25 Jan. and at all other times the ſun riſes and ſets every 24 hours. At the ſouth cape of Spitzbergen L. D. and N. almoſt 4 months; day begins about 25 April, ends 17 Auguſt; night begins 26 October, ends 14 February; and at all other times the ſun riſes and ſets every 24 hours. *QUEST.* 3. In what latitude is the length of the longeſt day equal to 61 natural days—92 days—4 months and 10 days? *ANS.* 70°—73½°—80° nearly.

LESSON XXIV.

PROBLEMS PERFORMED BY THE TERRESTRIAL GLOBE.

PROB. XXI. *Any time, between the vernal equinox and the ſummer ſolitice, or between the autumnal equinox and the winter ſolitice, being given, to find all thoſe places, where the ſun begins to be conſtantly above the horizon without ſetting; and thoſe places, where the ſun begins to be conſtantly below it without riſing.* 1. Find the ſun's declination on the given day, (by Prob. 10,) and note that degree on the meridian, counted from the neareſt pole, which anſwers to the ſun's declination —then turn the Globe on its axis—and all places, which paſs under the degree noted, are thoſe to which the ſun then begins to be conſtantly above the horizon without ſetting. 2. Note the ſame degree on the meridian, counted from the oppoſite pole—and all places, which paſs under that degree, are thoſe to which the ſun then begins to be conſtantly below the horizon without riſing.

PROB. XXII. *To find the beginning and ending of morning and evening twilight, in any latitude, at any given time, when the ſun riſes and ſets within 24 hours, and its midnight depreſſion is* *greater than* 18°. 1. Rectify for the latitude, the zenith, and the ſun's place—then bring the ſun's place to the eaſtern part of the horizon—note the oppoſite point of the ecliptic, which is at the ſame time on the weſtern part of the horizon, and raiſe that point till it is directly under the 18th degree of the quadrant of altitude—the ſun's place for the given time is then 18° below the horizon, and the index will point to the hour when the morning twilight begins, or the dark night ends. 2. Next let the ſun's place be brought to the weſtern part of the horizon—note the oppoſite point of the ecliptic, and raiſe it till it is directly under the 18° of the quadrant—the ſun's place is then 18° below the horizon, and the index will point to the hour when the evening twilight ends, or dark night begins.

PROB. XXIII. *To find the time when continual twilight begins and ends in any latitude greater than* 48½°.* Rectify for the latitude and note the point of the meridian which is exactly 18° beneath the part of the horizon neareſt the elevated pole—then, turning the globe, obſerve the two points of the ecliptic, which paſs under the degree noted, find the two days correſponding days—which will be the two days, one when continual twilight begins, the other when it ends.

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* In latitudes leſs than 48½ there is no *continual* twilight.

PROB. XXIV. *To find the two days in which the ſun is vertical to any given place within the torrid zone.* Bring the given place to the meridian and note the degree over it—then turn the globe and obſerve the two points of the ecliptic which paſs directly under the degree noted—look for theſe points of the ecliptic on the wooden horizon, and againſt them will be found the two days required.

PROB. XXV. *To find the places to which the ſun will be vertical on any given day.* Bring the ſun's place to the meridian, and note the degree over it—then turn the globe and all places, which paſs under the degree noted, will have the ſun vertical at the given day.

QUESTIONS.

How are all thoſe places found, where the ſun begins to be conſtantly above or below the horizon, at any given time, in the vernal or autumnal quarters? How is the beginning and ending of morning and evening twilight found, in any latitude, at any given time when the ſun riſes and ſets within 24 hours and its midnight depreſſion is greater than 18°? How is the time of continual twilight found, in any latitude greater than 48½°? How are the two days found in which the ſun is vertical at any given place? How are thoſe places found to which the ſun will be vertical on any given day?

Queſtions for exerciſe, &c.

QUEST. 1. What are the places to which the ſun begins to be conſtantly above or below the horizon, 20 May and 1 November? *ANS.* On the firſt day the ſun begins to ſhine conſtantly to all places in 20 N. Lat. and to be totally abſent from thoſe in 20 S. Lat. On the ſecond day the ſun begins to ſhine conſtantly to all places in 15° S. Lat. and to be totally abſent from thoſe in 15° N. Lat. *QUEST.* 2. At what hour does morning and evening twilight begin and end at London—12 May—and 12 Nov.?—*ANS.* May 12 M. T. begins 15 paſt 1. E. T. ends $45^{m.}$ paſt 10—M. T. begins $30^{m.}$ paſt 6. E. T. ends $30^{m.}$ paſt 6—*QUEST.* 6. At what time does continual twilight begin and end at London? *ANS.* It begins 18 May ends July 26. *QUEST.* 6. At what places will the ſun be vertical—20 May—21 Jan.? *ANS.* At all places in 20 N. Lat. on the former day, and at all places in 20° S. Lat. on the latter. *QUEST.* 7. What are the two days when the ſun is vertical at Barbadoes—and at Batavia? *ANS.* 25 Apr. 17 Aug. —9 Oct. 5 Mar.

LESSON XXV.

PROBLEMS PERFORMED BY THE TERRESTRIAL GLOBE.

PROB. XXVI. *The time at any place being given, to find where the ſun is vertical at that preciſe time.* Find the ſun's declination—bring the given place to the meridian, and ſet the hour index to the given time—turn the globe till the hour index points to 12 at noon—and the place directly under the ſame degree of the meridian, which anſwers to the ſun's declination, has the ſun vertical at the given time.

PROB XXVII. *The time of the day being given at any place, to find all thoſe places to which the ſun is then riſing, ſetting, or culminating; and where it is twilight, dark night, and midnight.* Find the place to which the ſun is vertical at the given time—rectify for the latitude of that place, and bring it to the meridian. Then, to all places in the weſt ſemicircle of the horizon, the ſun is *riſing*

—to thoſe in the eaſt ſemicircle it is *ſetting*—to thoſe under the upper half of the braſs meridian, it is *mid-day*—and to thoſe under the lower half it is *mid-night:* to all places within 18° beneath the horizon it is *twilight;* and, to thoſe at a greater diſtance below it, it is *dark night.*

PROB. XXVIII. *To ſhew at one view the changes of day and night, and of the ſeaſons in all parts of the earth.* 1. Rectify for the ſun's declination at any time—and conceive the ſun to be directly over that degree of the meridian, which anſwers its declination. Then, to all places above the horizon it will be day, and night to all below it—thoſe arches of the parallels of latitude, which ſtand above the horizon, are the *diurnal arches*, or the length of the day in all thoſe latitudes, at that time of the year; and the remaining parts of the ſeveral parallels are the *nocturnal arches*, or the length of the night. 2. Turn the globe ſlowly on its axis, from weſt to eaſt, repreſenting the true motion of the earth—then, the ſun, in the zenith, muſt dart its direct rays on the places directly under it; and to all other places, whether northward or ſouthward, its rays muſt ſall obliquely, as they come ſucceſſively to the meridian. 3. Obſerve any places, that are moving from the meridian towards the eaſt of the horizon—the ſun, ſtill in the zenith, ſeems to recede from them more and more to the weſt, till it is 90° diſtant, when it diſappears—and to all theſe places, now on the eaſt ſemicircle of the horizon, the ſun appears to ſet in the oppoſite point of the horizon to that in which they ſeverally are. 4. The globe ſtill moving—the motion brings the ſame places nearer and nearer to the half of the meridian under the horizon—where it will be midnight—then morning approaches, till the motion brings theſe places to the weſtern parts of the horizon—where the ſun appears riſing in the oppoſite eaſtern part—then the time of noon comes nearer and nearer till, the motion of the globe brings the ſame places under the meridian again. 5. Next rectify for the equator—the ſun, ſtill in the zenith, will enlighten half the globe from the north to the ſouth poles, and the horizon divide all the parallels into two equal parts, cauſing equal day and night every where. 6. Raiſe the north pole gradually—and obſerve how the diurnal arches increaſe in the northern, and decreaſe in the ſouthern hemiſphere. When the pole is elevated 23°, its greateſt north declination—the diurnal arches in northern latitudes have their greateſt lengths; thoſe in ſouthern, the leaſt,—the parallel $66^\circ\frac{1}{2}$, and all the parallels north of it, are entirely above the horizon; and the ſame parallels ſouth, are entirely below it; in all theſe parts, therefore, there will be continual day and night, each of longer duration as the places are nearer to the poles, where the day and night is always half a year.

QUESTIONS.

If any time of the day be given, how is the place found to which the ſun is then vertical? If the time of the day be given at any place, how are all thoſe places found, where the ſun is riſing, ſetting, culminating, and where it is twilight, dark night and midnight? How are the changes of day and night, and of the ſeaſons repreſented by the globe?

Queſtion, &c.

QUEST. Where is the ſun vertical 25 April when it is 52$^{m.}$ paſt 3 P. M. at London—and 18 May when it is 6¾ P. M. at the ſame place? *ANS.* Barbadoes—Mexico.

LESSON XXVI.

PROBLEMS PERFORMED BY THE CELESTIAL GLOBE.

PROB. I. *To find the declination and right aſcenſion of the ſun or any fixed ſtar.* Bring the ſun's place, or the ſtar, to the braſs meridian—the degree over it will be its declination—and the degree of the equinoctial, which is at the ſame time cut by the meridian, will be its right aſcenſion.

PROB. II. *To find the latitude and longitude of a fixed ſtar.* Bring the firſt of Cancer to the north point of the horizon—fix the quadrant of altitude over the pole of the ecliptic and bring its graduated edge over the given ſtar—the degree of the quadrant over it will be the latitude, and the degree of the ecliptic, reckoned from the firſt of Aries, which is cut by the quadrant, will be the longitude of the ſtar.

PROB. III. *To find the ſun's amplitudes, and its altitude and azimuth, at any given time, in any given latitude.* 1. Rectify for the latitude, the zenith, and the ſun's place—the number of degrees, between the horizon and the ſun's place, is its meridian altitude. 2. Move the globe till the index points to any other given hour—then bring the quadrant of altitude over the ſun's place—the degree over it will be the ſun's altitude; and the degree of the horizon, cut by the quadrant, will be the ſun's azimuths at that hour. 3. Bring the ſun's place to the eaſtern and weſtern parts of the horizon—and the ſun's amplitudes, at riſing and ſetting, will be found.

PROB. IV. *To find the amplitudes of any fixed ſtar in any given latitude, alſo its altitude and azimuth at any given time of the day.* 1. Rectify for the latitude, the zenith and the ſun's place—bring the fixed ſtar to the eaſtern and weſtern parts of the horizon, and againſt it will be found its amplitudes at riſing and ſetting. 2. Turn the globe till the index points to the given hour—place the quadrant of altitude directly over the fixed ſtar—then the degree of the quadrant above the ſtar ſhews its altitude; and the degree of the horizon, which is cut by the quadrant, ſhews its azimuth.

PROB. V. *To find the depreſſion of the ſun or any fixed ſtar below the horizon, and their azimuths when below it, at any given time, in any given latitude.* Rectify for the latitude, the zenith, and the ſun's place—find the point of the globe which is directly oppoſite to the place of the ſun or ſtar (in the ſame manner as the Antipodes are found on the terreſtrial globe, PROB. viii.)—then find the altitude and the azimuth of this oppoſite point, at the given time (by the laſt Problem), which will be the depreſſion and the azimuth required.

QUESTIONS.

How is the declination and right aſcenſion of the ſun or any fixed ſtar found? How is the latitude and longitude of any fixed ſtar found? How are the ſun's amplitudes, its altitude and azimuth, found, at any given time, in any given latitude? How are the amplitudes of a fixed ſtar in any given latitude, and its altitude and azimuth at any given time, found? How is the depreſſion and the azimuth of the ſun or any ſtar below the horizon, at any given time, in any given latitude, found?

Queſtions for exercise, &c.

QUEST. 1. What is the declination and right aſcenſion of the ſun Jan. 31—Ap. 5—July 21—Nov. 26? *ANS.* $17^{\circ}\frac{1}{4}$ S. D. 314° R. A.—$66^{\circ}\frac{1}{2}$ N. D. $14^{\circ}\frac{1}{2}$ R. A.—$20^{\circ}\frac{3}{4}$ N. D. $120^{\circ}\frac{1}{4}$ R. A.—

21 S. D. 242°¼ R. A. *QUEST.* 2. What is the declination and right aſcenſion of Aldebaran—Spica Virginis—Capella—Sirius? *ANS.* 16° N. D. 65° R. A.—10° S. D. 197° R. A.—45°¾ N. D. 74°¾ R. A.—16½° S. D. 98¼° R. A. *QUEST.* 3. What is the latitude and longitude of Arcturus–Formahaut–Pollux—Alioth? *ANS.* 31° N. Lat. 200° Long —20° S. Lat. 331° Long—7° N. Lat. 110° Long —54°½ N. Lat. 156 Lon. *QUEST.* 4. What are the ſun's amplitudes at London May 31—6 July —10 Nov? *ANS.* 38 N—40 N—29 S. *QUEST.* 5. What is the ſun's altitude and azimuth at London 21 May at 7 in the morn. and at ¾ paſt 2 in the afternoon? *ANS.* 24° Alt. 90° Az. 44°½ Alt. 60 Az. S. W. *QUEST.* 6. What is the ſun's altitude and azimuth at London 31 May at 10 in the morn. and at noon? *ANS.* 52 Alt. 50 Az. S. E. —60½ Mer. Alt. *QUEST.* 7. What are the amplitudes at London of Markab—Bellatrix—Cor Hydrœ? *ANS.* 24 N—11 N—11½ S. *QUEST.* 8. What is the altitude and azimuth of Algol—Dubhe—Procyon—Dec. 31 at 10 at night in Lat. 51½? 68° Alt. 71° Az. S. W.—44° Alt. 39 Az. N. E.—33° Alt. 50° Az. S. W. *QUEST.* 9. What is the depreſſion and the azimuth of the ſun below the horizon at London 1 Dec. at 10 at night? *ANS.* 52° Dep. 50° Az. N. W.

LESSON XXVII.

PROBLEMS PERFORMED BY THE CELESTIAL GLOBE.

PROB. VI. *To find the time of the riſing, culminating, and ſetting of a ſtar, on any given day, in any given latitude.* Rectify for the latitude and the ſun's place—then let the fixed ſtar be brought to the meridian, and to the eaſtern and weſtern parts of the horizon—and the hour index will point to the time required.

PROB. VII. *To find the time when a ſtar riſes or ſets coſmically or achronically to any given place.* Rectify for the latitude—bring the ſtar firſt to the eaſtern and then to the weſtern part of the horizon—obſerve the two points of the ecliptic, which are, at the ſame times, on the *eaſtern* edge of the horizon—and find the two correſponding days, which are the days of the ſtar's coſmical riſing and ſetting. 2. Bring the ſtar again to the eaſtern and weſtern parts of the horizon—obſerve the two points of the ecliptic then on the *weſtern* edge of the horizon—and the two correſponding days, will be the days of the ſtar's achronical riſing and ſetting.

PROB. VIII. *To find the time when a ſtar* *riſes or ſets heliacally.* 1. Rectify for the latitude and the zenith—bring the ſtar to the eaſtern edge of the horizon—move the quadrant, on the weſtern ſide, till its 12th deg.* cuts the ecliptic—note that point of the ecliptic which the quadrant cuts and find the oppoſite point—the correſponding day will be the time of the ſtar's heliacal riſing. 2. Bring the ſtar to the weſtern ſide of the horizon—and on the eaſtern ſide place the 12th deg. of the quadrant over the ecliptic, find the oppoſite point, & the correſponding day will be the time of the ſtar's heliacal ſetting.

PROB. IX. *To ſhew at one view the ſituation of the fixed ſtars at any given hour; alſo to find the time in which different ſtars will riſe, culminate and ſet; and the ſtars that will never riſe and ſet in the given latitude.* Rectify for the latitude and the ſun's place and turn the globe till the index points to the given hour—then all thoſe ſtars that are in the eaſtern part of the horizon are riſing, thoſe on the weſtern part are ſetting, and thoſe under the meridian are culminating. 2. Turn the globe on its axis from eaſt to weſt—the index will ſucceſſively point out the times in which different ſtars riſe, culminate and ſet. 3. Turn the globe—and obſerve the ſtars that are not more diſtant from the elevated pole than the latitude of the place—alſo the ſtars that are not more diſtant from the depreſſed pole than the ſame latitude—the firſt are always above, and the laſt always beneath, the horizon of the given place.

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* Stars of the firſt magnitude are at 12° diſtance from the ſun in their heliacal riſing and ſetting—but ſtars of leſs magnitude are at greater diſtances.

PROB. X. *How to gain a knowledge of the fixed ſtars by means of the Globe.* Rectify the Globe to the preſent ſituation of the ſtars (by Prob. 9) and by means of a compaſs place the meridian of the Globe due north and ſouth—the principal fixed ſtars in the heavens will then be nearly in a direct line from the correſponding ſtars on the Globe—and a ſtrait wire placed perpendicularly on any ſtar on the Globe, will nearly point to the ſtar in the heavens which it repreſents.

PROB. XI. *To find the place of any planet on the Globe, and to ſhew the time of its riſing, ſouthing, and ſetting.* See in any ephemeris the place of the planet in the ecliptic, for the given day of the month; and, according to its latitude and longitude mark the ſame with a chalk upon the globe. Then, by prob. 6th, find the time of its riſing, ſouthing, &c.

QUESTIONS.

How is the time of the riſing, culminating, and ſetting of a ſtar, on any given day, in any given latitude found? How is the time of any ſtar's coſmical and achronical riſing and ſetting found? How is the time of any ſtar's heliacal riſing and ſetting found? How is the ſituation of the ſtars at any hour, and the times of their riſing and ſetting ſhewn by the globe? How is a knowledge of the ſtars in the heavens to be obtained by means of the globe? How is the place of any planet, and the times of its riſing and ſetting ſhewn by the globe?

Queſtions for exerciſe, &c.

QUEST. 1. What is the time of the riſing, ſetting, and culminating of Caſtor—Sirius—and Alpheta—at London Jan. 31? *ANS.* Caſtor riſes $\frac{1}{2}$ paſt 12 at noon—culm. at $20^{m.}$ paſt 10 P. M.—ſets at 8 A. M. Sirius riſes at 5 P. M.—culm. $35^{m.}$ paſt 9 P. M.—ſets at $10^{m.}$ paſt 2 A. M. Alpheta riſes $9\frac{1}{2}$ P. M.—culm. $22^{m.}$ paſt 6 A. M. *QUEST.* 2. What is the time of the coſmical riſing and ſetting of Sirius in Lat. $51^{\circ}\frac{1}{2}$? *ANS.* It riſes 10 Aug. ſets 15 Nov. *QUEST.* 3. What is the time of the achronical riſing and ſetting of Aldebaran in Lat. $51^{\circ}\frac{1}{4}$? *ANS.* It riſes 8 Dec. ſets 21 May. *QUEST.* 4. What is the time of the heliacal riſing and ſetting of Arcturus in Lat. $51^{\circ}\frac{1}{2}$? *ANS.* It riſes8 Oct. ſets2 Dec. *QUEST.* What ſtars never riſe or ſet in Lat. $51^{\circ}\frac{1}{2}$. *ANS.* See the catalogue of the ſtars Leſſ. 17.

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